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## THE MARCHING OF THE LARVA OF THE MAIA MOTH, *HEMILEUCA MAIA*.

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In the autumn of 1901 while collecting along the marshy shore of Lake Wingra, near Madison, I noticed many specimens of the maia- or buck-moth, *Hemileuca maia*, flying low over the marsh. Both males and females were present, and many of the latter, having settled, were laying their eggs on the grass. These were placed in a somewhat irregular set of spirals closely packed together so that when they hardened, the grass could often be pulled away leaving the eggs stuck together and forming a short tube. The process of oviposition and the arrangement of the eggs has been described by Riley<sup>1</sup> and copied by Packard.<sup>2</sup>

Without having any definite plans in view I collected a great many of the eggs most of which I put in a cold place, but a few I left in an open bottle in my room. One morning I noticed on the neck of this bottle a black mass which was found to be a group of young caterpillars; they had evidently hatched but a short time before. Later in the morning I again looked at the eggs and found that more had hatched; all in the first bunch, having in the meantime left the bottle, were marching in a line on the table. Again, later in the day other groups were seen, and in nearly every instance, each group had formed a line marching in a regular procession and following the leader whichever way he turned. I placed some large sheets of paper on the table; upon these the different groups were soon marching, and could be much more easily seen than when upon the darker table. I now, with a pencil, knocked the leader away from one line and was surprised to see the next in the line, now the leader, stop when he reached the place occupied by the first leader prior to his removal. Here he stopped and raising himself upon his prolegs moved the anterior part of his body to and fro as if he

<sup>1</sup> Riley, C. V., "Fifth Missouri Report," p. 128.

<sup>2</sup> Packard, A. S., "Insects Injurious to Forest and Shade Trees," Washington, 1890.

were trying to scent the leader. He soon discontinued this and resumed his natural position again, appearing, however, for some time, very restless. While this had been going on, the rest of the caterpillars had crowded up to the front one; they appeared for some time very restless, but finally settled in a close bunch, in which position they all remained: one here and one there would often become restless for a few minutes, but end by settling again in its former position in the bunch. I now marked the original leader (he had been kept away from the others all of this time) by putting a little white paint on his back and then picking him up on a small piece of paper dropped him back at the edge of the group. The leader, in the meantime, had been walking around evidently seeking the other caterpillars, and when he returned to the bunch, began to walk restlessly around near its edge. In a few minutes he started off away from the others and these began to follow him, moving in a regular procession.

Different masses of the eggs were now brought into my room, a few each week, and when the caterpillars hatched, a few experiments were carried on to see if the removal of the leader always affected the followers in the same way, and if a new caterpillar would not assume the leadership and be followed by the rest. The results I have thought it best to write out briefly and not to arrange them in a tabulated form. The first set contains those in which the old leader, upon being returned to the bunch, resumed command, and the second lot, those experiments in which a new caterpillar became the leader. There then follow a few experiments differing from those contained in the first two lots. When the number of caterpillars forming the line was counted, this is given; but in some cases, however, the number which formed the line was not noted.

In nearly every instance the removal of the leader brought about at first the same result. When I removed him I would draw a line on the paper marking a place where his head was before removal. When the second caterpillar in the line reached this point, he always stopped, rarely crossing the line, and when the bunch was formed, it was always back of the line.

1. Sixty-four in line. 8:15, leader removed; 8:30, all bunched; 8:31, leader returned; 8:35, all restless; 9:00, leader started, and at 9:08, all were in line and moving.

2. Six in line. 8:45, leader removed, others soon bunched ; 8:51, leader returned ; 8:57, old leader started ; others following.

3. 8:47, leader removed ; 8:50, all bunched ; 8:51, leader returned ; he passed to back of bunch and started away, others following ; 8:43, all in line.

4. Ten in line. 8:31, leader removed and all bunched one inch back of line ; 8:36, leader returned ; 8:55, leader starts and others follow.

5. 8:57, leader removed and put back at once, seventh in the line ; all bunched ; 4:06, P. M., leader started, others following.

6. 8:16, leader removed ; 8:26, leader returned ; 8:31, leader started, others following.

7. 8:21, leader removed ; a caterpillar, the next in line, goes on half an inch and here they all bunch ; 8:30, leader returned ; 8:42, leader starts and others follow.

8. 2:32, leader removed ; 2:47, leader returned to bunch ; 3:55, leader started, others following.

9. One hundred and fifty in line. 10:22, leader removed ; 10:40, bunched and leader returned ; 11:25, leader started and others followed.

The following are experiments where a new leader started :

1. Forty in line. Leader removed ; 9:10, bunched ; 9:11, a caterpillar at back of bunch starts and others follow.

2. Twenty-one in line. 9:01, leader removed ; 9:08, bunched ; 9:10, one near front starts ; 9:21, all in line following new leader.

3. Eighteen in line. 8:50, leader removed ; in a minute the next caterpillar turned and started ; 8:55, all in line and following new leader.

4. Thirty-six in line. 8:42, leader removed and the next caterpillar assumes leadership ; 8:47, new leader removed and original one put back in middle of line ; all bunch ; and at 4:08, P. M., were still quiet.

5. Eighteen in line. 8:30, leader removed ; 8:37, bunched ; one went a short distance over the line but returned ; leader returned ; 8:46, new leader started and others follow.

6. Eleven in line. 8:38, leader removed ; 8:41, next caterpillar returned along the line two inches and then came back ; others bunched ; 8:45, start with new leader.

7. Ten in line. 10:34, leader removed ; line kept on ; 10:39, second leader removed ; march continued ; 10:40, third leader removed ; 10:42, bunched ; 10:48, started with the original leader, who had been returned, at head.

8. 8:13, leader removed ; 8:22, leader returned ; 8:56, new leader started, others following.

9. 2:56, leader removed ; 3:05, leader returned ; 4:05, new leader started and others follow.

10. Forty-six in line. 9:24, leader removed ; 9:33, all bunched ; leader returned ; 10:05, new leader starts and others follow.

11. One-hundred and twenty in line. 8:41, leader removed ; when the entire line had bunched the leader was returned ; 11:45, new leader starts and others follow.

12. One-hundred and fifty in line. 8:43, leader removed ; 9:25, mostly bunched and leader returned ; 10:10, old leader started, rest following ; they went more than an inch and then returned to bunch again ; 2:30, P. M., a new leader starts and others follow.

The following experiments were made by removing the leaders of two lines and then returning them each to the other's bunch :

*A.* Six in line. 2:02, leader removed ; 2:06, bunched ; leader of *A'* placed near head ; 2:08, leader of *A'* starts and others follow.

*A'*. Thirty-two in line. 2:02, leader removed ; 2:07, leader of *A* placed in bunch ; 2:11, one, not the leader, started but returned ; 2:35, leader of *A* starts and others follow.

*B.* Thirty-two in line. 1:56, leader removed, when others bunched leader of *B'* placed with them ; 2:18, leader from *B'* starts and others follow.

*B'*. Thirty-five in line. 1:56 leader removed and leader of *B* placed in bunch ; 2:03, leader of *B* starts and others follow.

*C.* 1:22, leader removed ; 1:27, leader of *C'* placed in bunch ; 3:20, line starts with entirely new leader.

*C'*. 1:22, leader removed ; 1:27, leader of *C* placed in bunch. Called away and unable to follow this to end.

The following experiments I give separate from the others :

1. 8:24, leader removed ; 8:33, leader returned and at once started out, the other caterpillars remaining in bunch ; 8:38,

leader returned again ; 8:42, he starts out again but none follow ; in two minutes he returns to the bunch himself and starts a third time, this time some follow but soon return to bunch and leader goes off by himself.

2. Eighteen in line. 8:32, leader removed ; 8:38, bunched ; leader returned and they remained in bunch all morning.

3. Thirteen in line. Same thing happened as in number two.

In one lot, thirty-six in line, the leader had been marked and the line allowed to go on. The leader reached the last caterpillar in the line so that a circle was formed. They all kept moving, the leader finally reaching the place where he was when the circle was first formed ; he then went half way around the circle and started off in another direction the others following.

From the above, it will be seen that the removal of the leader affects the whole line, but that he is not necessary for the further progression of the caterpillars. I have been unable to find references to the procession-caterpillar, but notice that the caterpillars of *Saturnia io*<sup>1</sup> march when young the same as the Maia-moth.

Dubois<sup>2</sup> notes that the procession-caterpillar spins a thread which the others in the line follow ; the young larvæ of *Hemileuca* do the same, the thread being seen with a hand lens back of the line. In nearly all of the long lines, which the larvæ form, there is very apt to be at least one break where there is an inch or more between the nearest caterpillars, or such a break can be made by stopping one of the larvæ until the preceding ones have gone ahead for some distance : at such a place the thread also can be seen. When a break occurs, it does not in any way affect the movements of the line, the caterpillars following along the regular path.

Wishing to see how much the caterpillars depended upon this thread to enable them to follow in the exact path of the leader, I removed the thread a number of times when the distance between two neighboring caterpillars was great enough, and found that the course was not in the least altered. The caterpillars, upon reaching the end of the broken thread, generally kept straight on as if nothing had been done, failing to show a dependence

<sup>1</sup> Dickerson, Mary C., "Moths and Butterflies," 1901.

<sup>2</sup> Dubois, *Ann. Soc. Linn. Lyon.*, XLXI., 1900, p. 125.

upon the thread alone in following the path of those ahead. I next removed the thread, and then dipping a finger in water, rubbed it rapidly a number of times across the path and then wiped the place dry. When the first caterpillar reached this spot, he halted, and for three minutes remained at the same place, raising the anterior part of the body in the air acting the same as if the leader had been removed. At the end of this time he started forward following, as near as I could judge, the original path.

The following few experiments should have been made with the food plant of the caterpillar, but this being unobtainable at the time of the year when the caterpillars were hatching in my room, the leaf of the geranium, *Pelargonium*, which was easily obtained and possessed quite an odor, was used.

1. A small piece of the leaf was placed 5 mm. away from a small group which had been quiet for two or three hours; the caterpillars became at once restless and in two minutes, three had moved over and touched the leaf.

2. A small piece of the leaf was placed 5 mm. away from the leading caterpillars in a line; they became at once restless and "broke rank"; in four minutes two (not the leader) had reached the leaf.

3. A piece of leaf was placed 15 mm. from a group, nothing happened; the leaf was moved to 10 mm. and left for ten minutes, nothing occurred; moved to distance of 5 mm. from caterpillars and all still remained quiet. I now moved the leaf to 3 mm. away, one immediately came out, touched the leaf and returned to its original position, in thirty seconds another came out, touched the leaf and returned.

4. A piece of leaf was placed 5 mm. from group, two came out, touched it and returned.

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